

Performance assessment of children based on the selected motor tests

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ABSTRACT

Introduction: Speed of movement refers to the max. speed of moves that an individual is able to perform, associated with the optimal activation of muscle fibers. It increases until the age of 15 in girls and 18 in boys, with the fastest rate 6–14 years of age. In boys, 2 periods of a particularly intense increase in speed are observed: 7–10 and 13–15 years of age.

The aim of the study was to assess the level of speed in girls and boys aged 9–10-years-old from school groups with an extended physical education program and those from regular groups.

Materials and methods: This study, performed every year 2003–2013, involved 470 children aged 9–10 years, finishing the 3rd year of the primary school. A 30 m run and long jump were used to test the speed of the children. The study method was based on the selected elements of the Denisiuk test.

Results: The tests showed that boys were faster than girls. Every year, they obtained better average score for the 30 m run and tests. The lowest difference between sexes was noted in 2013. We also demonstrated that almost in all years the candidates for cross-country skiers were faster than the students assigned to groups with no extra sports classes.

Conclusions: Our study confirmed higher speed in 9–10-year-old boys than in girls, especially in long jump tests. Children with higher fitness level were faster than their less active peers. The deterioration of speed test results in the subsequent years of the study is an unfavorable trend that requires further long-term research.

Keywords: long jump; 30 metres run; speed; children.

INTRODUCTION

In sport, speed of movement refers to moves that an individual performs at a max. speed [1], which is associated with an optimal activation of muscle fibers [2]. It depends on the highly specialized functions of the neuro-muscular system (ability to relax muscles, fast and synchronized response to stimuli – reaction time), muscle strength, frequency of muscle contraction, elasticity of muscles, body temperature, optimal involvement of muscle fibers and the entire muscle, muscle ATP levels, the rate of ATP breakdown, and the range and technique of movement [3].

Human ontogenesis includes periods varying in terms of increase in movement speed, an important criterion for selection of young children to various sports disciplines. That is why it is important to determine the fundamental ontogenic conditions and other factors that may affect the speed of movement [4].

The age of 7–12-years is characterized by a steady, though slow, growth in height and weight. The girls grow slightly faster than boys. This period is associated with an increase in the muscle mass, development of the nervous system, and improvement in coordination. At this age, children show high

speed and easily acquire motor skills. A period of 10–13-years is called "the golden age" to emphasize the excellence of the efficiency of the child, which applies particularly to girls. The age 12–14-years-old is the phase of maturation and rapid linear growth. This period is associated with further development of muscles, but not always accompanied with the matching growth of other systems, which hinders a further increase in speed. Adolescence (14–18-years-old) is the period of developing functions of the nervous system, muscular system, coordination, and increased adaptive abilities of the circulatory system. Therefore, speed of movement increases until 15 in girls and 18 in boys. The fastest rate of increase of this parameter occurs 6–14-years of age. In addition, boys show 2 periods of particularly intense growth of the speed rate – 7–10 and 13–15-years. At the age of 8–12-years, differences in speed test results between girls and boys are small [5, 6].

OBJECTIVE OF THE WORK

The aim of the study was to assess the level of speed of movement in girls and boys aged 9–10-years that were qualified for

special groups with extended sports curriculum and those from normal groups with a regular program of physical education.

MATERIALS AND METHODS

The study involved 470 schoolchildren aged 9–10-years, finishing the 3rd year of the Primary Sports School in Supraśl and the local Primary School in Ogrodniczki. The children examined in the years 2003–2013, were divided into 2 groups: pupils qualified for the sports-oriented curriculum (with extra classes of cross-country skiing; $n = 178$) and students not qualified for any special sports-oriented program of education ($n = 292$). The results were obtained from the physical education teachers and coaches of individual groups. The incomplete data for the years 2000, 2002, 2005 and 2006 are due to the lack of requirement for archiving the fitness results of pupils by physical education teachers. The methodology of the tests was based on the Denisiuk test and guidelines issued by the Board of School Sports Association [7, 8]. The tests took place at the city stadium in Supraśl – a runway of standard length of 400 m and the long jump runway. To estimate the speed, 30 m run and long jump tests were used [9]. In the protocol proposed by Denisiuk [7], a 30 m run consists in running over this distance in the shortest possible time. The test is performed individually in sports shoes (not with spikes) from a standing start. The distance is marked with flags or lines drawn at the start and finish. A timer is used to measure time. The result

is given with the accuracy of 0.1 s and converted into points using point tables.

According to the Guidelines of the School Sports Association [8] the long jump is performed from a runway. Each tested person determines the needed run-up length. The jump length is measured from the place of take off (a trace left closest to the sandbox) within the 1 m zone, to the nearest mark left on the sand. The zone is defined from the edge of the beam closer to the sandbox towards the beginning of the take-off run. Each jumper is entitled to perform 2 test jumps and 3 measured jumps. The result is given in cm. The best result is recorded and taken into account during calculation of the total score.

Statistical analyses were performed using Statistica 10. Descriptive data of the quantitative variables are presented as the values of the standard deviation. The examined groups were compared using the non-parametric Mann–Whitney U test. Differences were deemed statistically significant at $p < 0.05$.

RESULTS

In the overall ranking, the boys achieved better average 30 m run times compared to girls in each year studied. Significant differences were observed in 2003 and 2005 ($p < 0.05$). The best result in boys was recorded in 2008 – 5.04 s (18.03 points). The worst result was noted in 2013 – 5.36 s (13.39 points) – Table 1.

TABLE 1. The average times for a 30 metres run and the average total points in girls and boys

Year	Sex	Average		SD		Min.		Max.	
		time (s)	points	time (s)	points	time (s)	points	time (s)	points
2003	boys	5.05	17.96	0.39	6.11	4.3	7	5.9	32
	girls	5.35	13.41	0.47	6.06	4.5	2	6.4	28
2004	boys	–	–	–	–	–	–	–	–
	girls	–	–	–	–	–	–	–	–
2005	boys	5.06	17.67	0.38	6.34	4.3	8	5.8	32
	girls	5.23	14.95	0.37	5.51	4.4	6	6.0	30
2006	boys	–	–	–	–	–	–	–	–
	girls	5.20	15.40	0.37	5.47	4.5	5	6.1	28
2007	boys	5.19	15.75	0.49	5.99	4.5	0	7.1	28
	girls	5.28	14.44	0.41	5.92	4.5	5	6.1	28
2008	boys	5.04	18.03	0.36	6.27	4.4	9	5.7	30
	girls	5.19	15.75	0.44	5.97	4.5	1	6.5	28
2009	boys	–	–	–	–	–	–	–	–
	girls	5.38	13.00	0.44	5.46	4.6	1	6.5	26
2010	boys	–	–	–	–	–	–	–	–
	girls	–	–	–	–	–	–	–	–
2011	boys	5.14	17.09	0.58	7.85	4.3	0	6.8	32
	girls	5.27	14.37	0.38	4.96	4.8	1	6.5	22
2012	boys	5.14	15.96	0.31	4.69	4.6	8	5.8	26
	girls	5.20	15.43	0.33	4.62	4.8	7	4.8	22
2013	boys	5.36	13.39	0.46	6.11	4.6	2	6.4	26
	girls	5.37	12.69	0.27	3.55	4.8	8	5.8	22

Girls surveyed in 2008 showed to be the fastest, reaching an average time of 5.19 s (15.75 points). The highest average time for 30 m run – 5.38 s (13.00 points) was observed in the next year (Tab. 1).

Each year boys qualified for the extended sports curriculum had better average results in the speed test than their colleagues not qualified for extended training program ($p < 0.05$). The best average time for a 30 m run in male pupils having extra ski classes was achieved in 2005 – was 4.78 s (22.58 points). The worst result was obtained by the students examined in 2013. In boys with a regular program the worst average time (2013) compared to the best result (2008) differed by 0.46 s (Tab. 2).

In case of girls, the candidates for cross-country skiers were faster than the students assigned to unsportsmanlike classes ($p < 0.05$). The best average result of future athletes was observed in 2008 – 4.84 s (21.11 points). By far, the weakest one was noted in 2013 – 5.35 s (12.64 points). It was demonstrated that the girls from unsportsmanlike classes achieved the best average result in 2005 – 5.31 s (13.64 points) while the worst one was noted in 2009 – 5.60 s (10.10 points) – Table 2.

In the long jump boys obtained better results than girls (Tab. 3). Their best result reaching 326.92 cm (39.19 points)

was noted in 2008. The lowest was observed in 2011 – 273.64 cm (22.95 points). The difference between the best and the worst average values was 53.28 cm (16.24 points).

Girls obtained the best result of 286.62 cm (27.21 points) in 2003. The shortest long jump distance was reached by the girls examined in 2011 – 246.52 cm (13.97 points). These results differed by 40.10 cm (13.24 points).

The statistically significant differences ($p < 0.05$) between the best and the worst results in both examined sexes are presented in Table 3.

The boys assigned to the ski classes had better muscle explosive force of lower limbs in comparison to their colleagues qualified for a regular physical education program. Significant differences in the long jump distance groups of boys qualified for the extended and regular physical education curricula were recorded in the years 2005–2013 ($p < 0.05$). The future athletes achieved the best average jump result in 2008, which was – 347.73 cm (46.00 point). The worst result was obtained by boys examined in 2013 – 294.38 cm (29.31 point). Among students assigned to the regular curriculum, the top result for this test, 317.76 cm (36.20 points), was recorded in 2008. The weakest one was 62.43 cm (18.62 points), observed in 2011 (Tab. 4).

TABLE 2. The average times for a 30 metres run and the average total points in girls and boys qualified for an extended and regular training curriculum

Year	Sex	Children qualified for an extended physical education curriculum								Children qualified for a regular physical education curriculum							
		av.		SD		min.		max.		av.		SD		min.		max.	
		time (s)	points	time (s)	points	time (s)	points	time (s)	points	time (s)	points	time (s)	points	time (s)	points	time (s)	points
2003	boys	4.85*	20.91*	0.24	4.85	4.3	16	5.1	32	5.22	15.46	0.42	6.10	4.6	7	5.9	26
	girls	5.01*	18.00*	0.24	4.65	4.5	13	5.3	28	5.56	10.91	0.45	5.27	4.9	2	6.4	20
2004	boys	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	girls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2005	boys	4.78*	22.58*	0.34	6.22	4.3	11	5.5	32	5.20	14.90	0.32	4.50	4.7	8	5.8	24
	girls	5.07*	17.67*	0.41	6.88	4.4	8	5.8	30	5.31	13.64	0.32	4.28	4.8	6	6.0	22
2006	boys	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	girls	4.99*	18.45*	0.27	4.89	4.6	12	5.4	26	5.46	11.77	0.35	4.17	4.9	5	6.1	20
2007	boys	4.87*	20.36*	0.24	4.80	4.5	14	5.2	28	5.34	13.72	0.24	5.35	4.5	0	5.2	22
	girls	4.91*	19.90*	0.29	5.63	4.5	13	5.3	28	5.42	12.35	0.36	4.60	4.7	5	6.1	24
2008	boys	4.79*	22.36*	0.28	5.28	4.4	12	5.4	30	5.15	16.12	0.34	5.77	4.4	9	5.7	30
	girls	4.84*	21.11*	0.19	3.89	4.5	16	5.1	28	5.35	13.21	0.43	5.06	4.9	1	6.5	20
2009	boys	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	girls	5.02*	17.83*	0.20	3.83	4.6	13	5.3	26	5.60	10.10	0.39	4.06	5.1	1	6.5	16
2010	boys	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	girls	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2011	boys	4.84*	21.60*	0.36	6.24	4.3	10	5.6	32	5.39	13.33	0.62	7.20	4.6	0	6.8	26
	girls	5.10*	16.36*	0.19	3.41	4.8	12	5.4	22	5.37	13.21	0.43	5.41	4.8	1	6.5	22
2012	boys	4.93*	19.60*	0.27	4.50	4.6	10	5.6	26	5.28	13.53	0.24	3.00	4.9	8	5.8	20
	girls	4.99*	18.40*	0.17	2.95	4.8	12	5.4	22	5.35	13.15	0.33	4.43	4.8	7	5.9	22
2013	boys	5.07*	17.46*	0.33	5.39	4.6	10	5.6	26	5.61	9.87	0.41	4.27	5.0	2	6.4	18
	girls	5.35	12.64	0.20	2.42	5.0	10	5.6	18	5.40	12.80	0.42	5.72	4.8	8	5.8	22

* $p < 0.05$ (differences between children from the extended and regular training curriculum)

TABLE 3. The average distance of the long jump and the average number of points in both of girls and boys

Year	Sex	Average		SD		Min.		Max.	
		time (s)	points	time (s)	points	time (s)	points	time (s)	points
2003	boys	300.54	31.00	28.97	9.22	350	47	220	6
	girls	286.62	27.21	39.61	10.84	355	48	150	0
2004	boys	-	-	-	-	-	-	-	-
	girls	-	-	-	-	-	-	-	-
2005	boys	295.79	28.91	33.07	10.25	370	53	234	11
	girls	276.35	23.35	34.72	10.80	349	46	210	3
2006	boys	-	-	-	-	-	-	-	-
	girls	267.83	21.00	42.13	12.84	336	42	198	0
2007	boys	296.14	29.53	42.72	13.03	370	53	190	0
	girls	266.33	20.56	36.13	10.56	352	47	186	0
2008	boys	326.92	39.19	38.21	12.31	431	74	268	21
	girls	260.61	18.82	41.62	12.48	358	49	188	0
2009	boys	-	-	-	-	-	-	-	-
	girls	254.16	16.75	37.03	10.99	334	41	187	0
2010	boys	-	-	-	-	-	-	-	-
	girls	-	-	-	-	-	-	-	-
2011	boys	273.64	22.95	41.82	12.18	360	50	177	0
	girls	246.52	13.97	36.55	10.61	340	43	170	0
2012	boys	293.52	28.68	36.93	11.41	360	50	230	9
	girls	254.96	17.61	35.14	9.70	315	36	165	0
2013	boys	275.61	23.54	30.97	9.43	340	44	205	2
	girls	254.36	15.25	25.42	8.43	301	31	220	0

Generally, better results in the long jump were achieved by those girls who were qualified to the extended program of physical education. The year 2013 was the only when the average result obtained by students qualified for regular program exceeded the average result achieved by the future sports-women, by 11.25 cm (0.36 points). Among the girls assigned to the skiing group, the highest average jump distance of 310.42 cm (34.08 points) was recorded in 2003, while the lowest one, 250.00 cm (15.36 points), was noted in 2013 (Tab. 4).

The best average result in the long jump in girls qualified for a regular curriculum was also recorded in 2003 – 273.64 cm (23.45 points). The worst one, lower by 38.79 cm (12.45 points) from the top result was observed in 2006 – 234.85 cm (11.00 points). Significant differences in the long jump results between girls qualified for the extended and regular curricula were recorded in 2003–2009 ($p < 0.05$) – Table 4.

DISCUSSION

Motor development of children and youth has been investigated by many teams of researchers worldwide. They usually focus on the ontogenetic development in both sexes. The main objective of this study was to analyze the changes in speed of movement in schoolchildren taking fitness tests at the end of the 3rd grade of the primary school over 11 years. There is only a few data in this field in the literature based on the observations of the phenomena rather than on scientific research.

The history of research on physical fitness in Poland dates back to the 1930s, when Mydlarski created a meter for physical fitness at the initiative of the Scientific Council of Physical Education. The meter was to objectify the evaluation of students of physical education. The scientific work in this area was continued by Trzeźniowski, then Denisiuk who created the set of tests, some of which were included in this study [2, 7, 9]. The comparison of speed test results performed in 1979 by Trzeźniowski with the values obtained in 1951–1966 revealed the improvement in short run rests [10]. The similar conclusion was drawn after analysis of the International Physical Fitness Test, performed at the Department of Theory of Physical Education in Warsaw in 1989 and 1999 [11].

Panek et al. found a significant advantage in speed in individuals with high physical fitness over their peers with low physical fitness [12]. Similar results were shown for sports students in Dudra's research conducted in 2007 among volleyball players in Wrocław [13]. Our results showing that 30 m run time among schoolchildren qualified for an extended training curriculum were better than among students qualified for the regular curriculum are in line with these findings [11, 13]. On the other hand, Matuszek showed poor results in the local boys with the extended training program at Winter Sports School in Szczyrk in 1981–1983. Three out of 5 had obtained similar results to boys with a regular curriculum.

According to Jezierski, boys are superior in their speed abilities over girls, although this difference is not markedly significant [14]. This observation was also confirmed by our results.

TABLE 4. The average distance of the long jump and the average number of points in girls and boys qualified for the extended and regular physical education curriculum

Year	Sex	Children qualified for an extended physical education curriculum								Children qualified for a regular physical education curriculum							
		av.		SD		min.		max.		av.		SD		min.		max.	
		time (s)	points	time (s)	points	time (s)	points	time (s)	points	time (s)	points	time (s)	points	time (s)	points	time (s)	points
2003	boys	312.27	34.82	26.77	8.65	275	23	350	47	290.62	27.77	27.90	8.71	220	6	320	37
	girls	310.42*	34.08*	19.59	6.08	280	25	355	48	273.64	23.45	42.01	11.12	150	0	320	37
2004	boys	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	girls	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005	boys	323.70*	38.10*	27.25	8.61	278	24	370	53	279.90	23.70	24.68	6.92	234	11	325	36
	girls	302.75*	31.58*	28.06	8.98	270	21	349	46	263.68	19.40	30.52	9.38	210	3	316	36
2006	boys	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	girls	299.31*	30.54*	35.29	10.82	221	7	336	42	234.85	11.00	21.79	6.60	198	0	271	22
2007	boys	330.09*	40.00*	25.75	8.29	280	24	370	53	281.20	24.92	40.30	12.10	190	0	345	45
	girls	290.80*	27.70*	27.04	8.47	256	17	352	47	256.92	17.81	35.11	10.10	186	0	313	35
2008	boys	347.73*	46.00*	38.02	12.52	270	21	431	74	317.76	36.20	35.22	11.18	268	21	383	57
	girls	299.33*	30.44*	38.08	11.89	246	14	358	49	242.26	13.32	29.14	8.45	188	0	287	27
2009	boys	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	girls	283.08*	25.33*	29.83	9.20	230	9	334	41	236.80	11.60	29.60	8.59	187	0	282	25
2010	boys	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	girls	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	boys	295.60*	29.40*	38.89	12.80	239	12	360	50	255.33	17.58	36.02	9.62	177	0	300	31
	girls	257.45	17.36	25.47	7.93	223	7	294	29	239.83	12.00	41.15	11.63	170	0	340	43
2012	boys	324.20*	38.20*	24.08	7.58	275	23	360	50	273.07	22.33	29.06	8.85	230	9	318	36
	girls	267.30	20.90	26.04	7.94	232	10	310	34	245.46	15.08	39.11	10.46	165	0	315	36
2013	boys	294.38*	29.31*	23.55	7.25	250	16	340	44	256.33	18.53	27.63	8.28	205	2	304	32
	girls	250.00	15.36	24.69	7.47	220	6	301	31	261.25	15.00	27.80	11.25	235	0	300	31

* $p < 0.05$ (differences between children from the extended and regular training curriculum)

The research conducted by Denisiuk, which was the prototype for the test performed at school in Supraśl showed the following results for the 30 m run: boys 5.9–6.1 s; girls 6.3–6.8 s. Average results obtained by us are clearly better – boys: 5.04–5.36 s, girls: 5.19–5.38 s [15].

Unfortunately, there is few data concerning the results of a long jump test among schoolchildren. In one available publication, Trześniowski showed better average results among Polish children in comparison with those from Czechoslovakia. Moreover, we observed trend in to improvement in long jump results over time as the measurements made by Trześniowski are in the lower end of the range of the results obtained in 11-year-old students from Supraśl in our study [10].

In the aforementioned study Trześniowski observed longer jump distances in boys than in girls. He added, however, that in the 7–12 years of age, these differences are relatively small but they increase over years. Most of the research on physical fitness including speed carried out until the 1980s suggested the growing physical fitness [10]. However, the new research by Raczek and also by Przewęda showed a deterioration in results [16, 17]. They suggest that factors associated with ubiquitous globalization as well as the development of civilization make life easier for people but also lower their physical activity. This may result in a decrease in the fitness of young

people. These negative trends in the motor field are accompanied by the acceleration in growth (expressed in height and body weight) and puberty. This phenomenon is called the scissors effect [3, 18, 19, 20, 21, 22]. In our study we also found year-on-year adverse trends in the level of physical fitness children demonstrated in motor tests.

Panek et al. in their study confirmed that children with extended training curriculum had better physical fitness than children who were not physically active [12]. Analogous conclusions were drawn from the research carried out on foreign cross-country skiers [23]. Identical observations were made also in this study.

All authors agree that the overall fitness level of boys is higher than that shown by girls [24, 25].

Our results also confirmed the differences in physical fitness according to sex. Concerning the age of the study group they could be related to the impact of factors such as hormonal changes during puberty. Boys between the ages of 9–10 are probably in the prepubertal or early pubertal phase. However, girls at this age have increased estrogen levels, which lead to changes in body proportions (increase in weight and body fat) and muscle function. The hormonal changes can therefore significantly contribute to the observed dimorphic differences [26, 27].

CONCLUSIONS

Our study confirmed the better speed results in 9–10-year-old boys compared to girls, especially in a long jump test. Children with higher fitness level were faster than their peers with a regular physical education curriculum. A gradual long-term deterioration of speed test results is an unfavorable trend that requires further research.

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